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MATRIC NO: 18/ENG05/004

DEPT: MECHATRONICS ENGINEERING

During the dry season in Ado-Ekiti, it is vastly seen that the drier **season** lasts 5.7 months, from October 24 to April 14, And during this period of time, it is usually a struggle for farms to cope with irrigation of farms and a major problem to run their various irrigation systems

What is Irrigation?

Irrigation is the process of applying water to the crops artificially to fulfil their water requirements. Nutrients may also be applied to the crops through irrigation. The various sources of water for irrigation are wells, ponds, lakes, canals, tube-wells, and even dams. Irrigation offers moisture required for growth and development, germination, and other related functions.

Water moistens the soil and thus helps in penetration of roots even into the dry field. The frequency, rate, amount and time of irrigation are different for different crops and also vary according to the types of soil and seasons. For example, summer crops require a higher rate of water as compared to winter crops.

Types of Irrigation

There are different types of irrigation practised for improving crop yield. These types of irrigation systems are practised based on the different types of soils, climates, crops and resources. The main types of irrigation followed by farmers include:

Surface Irrigation: In this system, no irrigation pump is involved. Here, water is distributed across the land by gravity.

Localized Irrigation: In this system, water is applied to each plant through a network of pipes under low pressure.

Sprinkler Irrigation: Water is distributed from a central location by overhead high-pressure sprinklers or from sprinklers from the moving platform.

Drip Irrigation: In this type, drops of water are delivered near the roots of the plants. This type of irrigation is rarely used as it requires more maintenance.

Centre Pivot Irrigation: In this, the water is distributed by a sprinkler system moving in a circular pattern.

Sub Irrigation: Water is distributed through a system of pumping stations gates, ditches and canals by raising the water table.

Manual Irrigation: This a labour intensive and time-consuming system of irrigation. Here, the water is distributed through watering cans by manual labour.

ABUAD FARM IRRIGATION SYSTEM

ABUAD farm uses a sprinkler irrigation system in which the central location of tanks of water and storages are located in the east corner of the farm close to the reservoir tanks serving the whole farm. Not afar this water system is the pumping system of the entire system.

This is proposing a system that will control all the activities from pumping system to the water storage management to distributing and following the sprinkler type of irrigation system of the farm

Generally the location of the farm makes it difficult to operate the pumping system, and during the dry season this becomes an impossible task especially during the management of the water and running the irrigation system.

A design of a software to control and automate the entire process is needed and this is entailed in this document

Sprinkler irrigation or overhead irrigation is a method of applying irrigation water which is similar to natural rainfall. Water is distributed through a system of pipes usually by pumping. It is then sprayed into the air through sprinklers so that it breaks up into small water drops which fall to the ground.

In contrast to surface irrigation, sprinkler systems are designed to deliver water to the field without depending on the soil surface for water conveyance or distribution. Sprinklers are designed and arranged to apply water at rates lower than soil in filterability to prevent ponding and surface runoff. The pump supply system, sprinklers and operating conditions must be designed to enable a uniform application of water.

1. Pump unit

2. Mainline and sub-mainlines

3. Laterals

4. Sprinklers

5. Pressure regulators

6. Filters

7. Flow control valves

8. Vacuum valve

9. Booster pump.

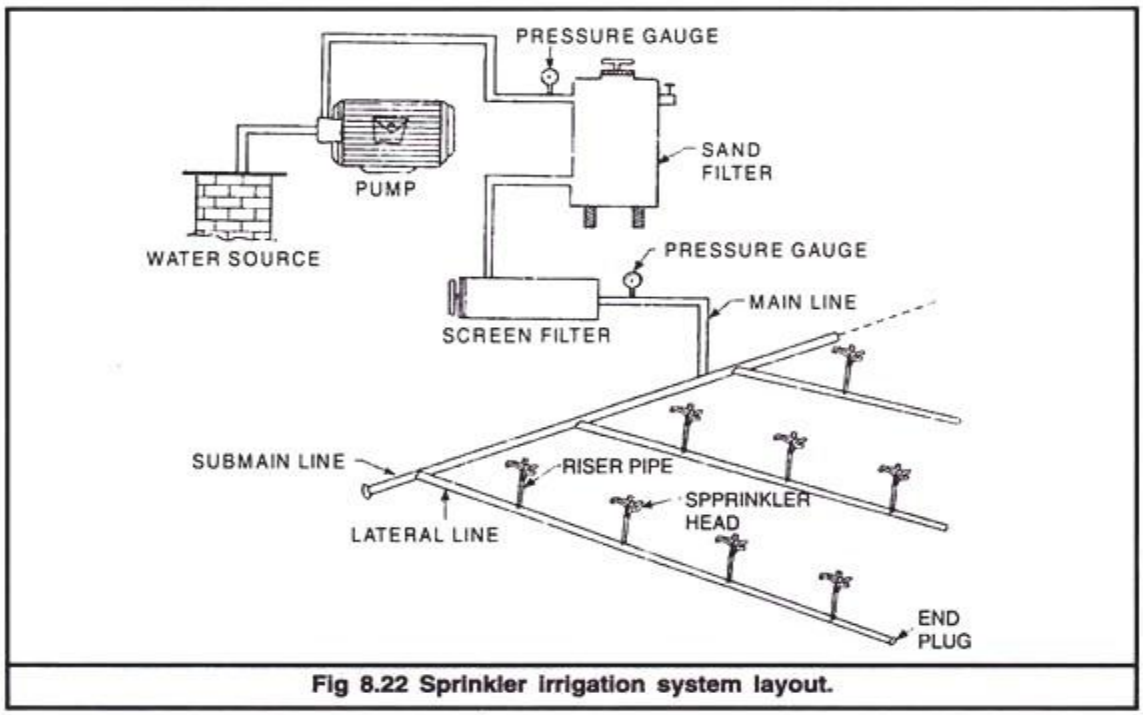


Fig 8.22 Sprinkler irrigation system layout.

The pump unit is usually a centrifugal pump which takes water from the source and provides adequate pressure for delivery into the pipe system.

The mainline – and sub-mainlines – are pipes which deliver water from the pump to the laterals. In some cases these pipelines are permanent and are laid on the soil surface or buried below ground. In other cases they are temporary and can be moved from field to field. The main pipe materials used include asbestos cement, plastic or aluminum alloy. The laterals deliver water from mainlines or sub mainlines to the sprinklers. They can be permanent but more often they are portable and made of aluminum alloy or plastic so that they can be moved easily.

The most common type of sprinkler system layout is shown in Fig above. It consists of a system of lightweight aluminum or plastic pipes which are moving automatically with instructions from the software. The rotary sprinklers are usually spaced 9-24 m apart

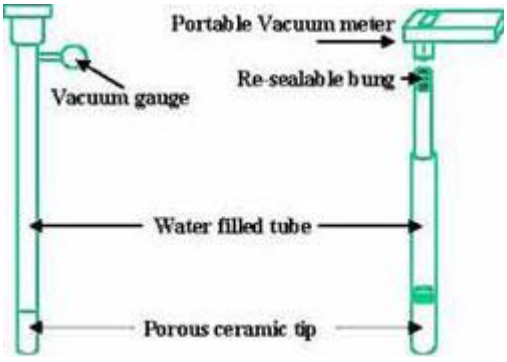
along the lateral which is normally 5-12.5 cm in dia. The lateral pipe is located in the field until the irrigation is complete.

The cycle of the software is as follows;

- At exactly 8:00 am and 5:00pm daily, an installed soil thermometer usually a mercury-in glass thermometer is used to check the temperature of the soil. If the temperature is high and (above 65-70^{0}F), there is a need for irrigation but cannot be confirmed except the moisture content of the soil to confirm the availability of water in the soil.
- After the temperature is confirmed and the result is sent back to the control panel, if the condition for the temperature is seen and the temperature of the soil is high, automatically the Tensiometers is activated.(device that measure soil moisture tension.) They are sealed, water-filled tubes with a porous ceramic tip at the bottom and a vacuum gauge at the top. They are inserted in the soil to plants' root zone depth. soil moisture will range from 10% to 45%,
- Upon return of the result, if the soil moisture is below 20% the tanks are activated and prepared for supply to the laterals and sprinklers, before that the level of water in the tanks and reservoirs will be checked to ensure that the tanks are above 50% capacity, if not a message is sent to the to control panels to start the pumping system after ensuring that there is electric supply to the pumping system, in a situation whereby there isn't electricity a siren and alarm will go off to indicate to the operator to provide a temporary source of electricity in form of batteries or fuel generators. After all this conditions are approved, the irrigation system comes on and there is supply of water to the sprinklers overhead the crops.
- Meanwhile without this conditions for irrigation, there are certain operations the software will enable the system to carry out;
    - The system would be accessed after entering an encrypted password and also providing some security information.
    - In an event of constant electricity the system automatically initiates the pumping system without any input from the operator.
    - A self-system check would be conducted by the system to check for any faults in the various components in the entire system
    - Setting of an indicator light/alarm to inform the operator about the fault detected during a self-system check.

Hardware features of the system

1. Soil thermometer: also called earth thermometer. A thermometer used to measure the temperature of the soil. Two forms of the mercury-in-glass thermometer are used for this purpose. For measurement at small depths, a thermometer with a right-angle bend in the stem is used. The bulb is inserted into a hole in the ground with the stem lying along the surface. A thermometer that has been fused into an outer protecting glass shield is used for measurement at greater depths. Wax is inserted between the bulb and the shield to increase the time constant. To obtain a measurement, the instrument is lowered into a steel tube that has been driven into the soil to the desired depth.
2. Tensiometer: A tensiometer measures soil moisture. It is an instrument designed to measure the tension or suction that plants' roots must exert to extract water from the soil. This tension is a direct measure of the availability of water to a plant. Tensiometers may be used in any irrigated crop, however, it is with horticultural crops in particular that they provide a suitable method to aid irrigation decisions. Tensiometers are most useful when a crop's water requirements are high and when any stress due to water shortage is likely to damage crop potential. A tensiometer consists of an air tight, water filled tube with a porous ceramic tip at the bottom and either a vacuum gauge at the top or a re-sealable rubber bung designed to insert a portable vacuum meter. During the irrigation season the tensiometer is partly buried in the soil to a suitable depth and, when used properly, will enable improved irrigation management by accurately determining when water should be applied to maintain optimum crop growth and how much water should be applied to avoid over-irrigating.



When buried in the soil the ceramic tip of the tensiometer allows water to move freely in or out of the tube. As the soil dries out, water is sucked out through the porous ceramic tip, creating a partial vacuum inside the tensiometer which is read on the vacuum gauge. When the soil is wetted by sufficient rainfall or irrigation, water flows back into the tensiometer, the vacuum decreases and the gauge reading is lowered.

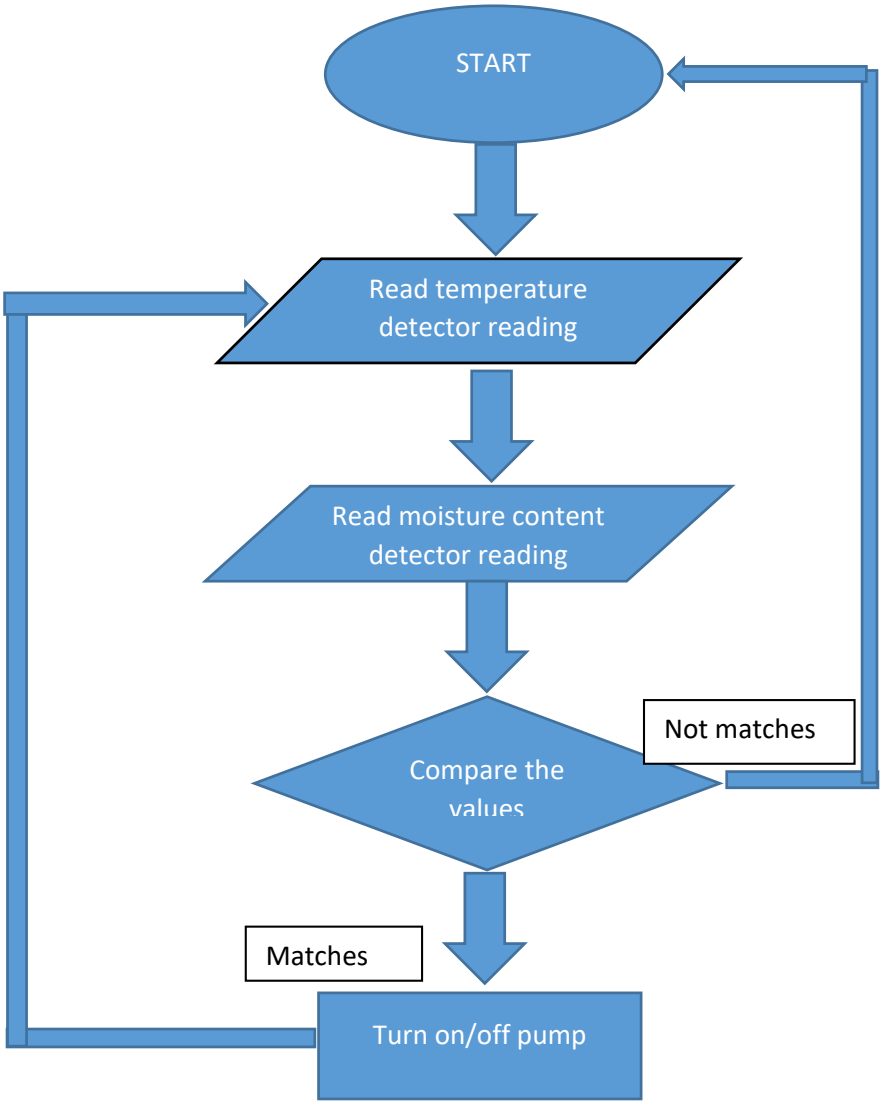
Tensiometers measure how tightly water is held to the soil particles and not how much water is left in the soil. A sandy soil will reach a high tension sooner than a clay loam because sandy soils cannot supply as much water to the plant and it is used up more quickly.

3. LED Indicator: Stands for "Light-Emitting Diode." An LED is an electronic device that emits light when an electrical current is passed through it. Early LEDs produced only red light, but modern LEDs can produce several different colors, including red, green, and blue (RGB) light. Recent advances in LED technology have made it possible for LEDs to produce white light as well. LEDs are commonly used for indicator lights (such as power on/off lights) on electronic devices. They also have several other applications, including electronic signs, clock displays, and flashlights
4. SIREN: a device that makes a loud prolonged signal or warning sound.
5. PUMP: A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action, typically converted from electrical energy into Hydraulic energy. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform mechanical work moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, and come in many sizes, from microscopic for use in medical applications, to large industrial pumps.
6. SPRINKLER: Sprinklers are mainly used to irrigate, or provide water, to plants. There are complex systems of sprinklers that can be installed in the ground for a large area, like a public park or an estate's acres of lawns. The more common type of sprinkler hooks up to a hose.
7. PRESSURE REGULATOR: A pressure regulator is a valve that controls the pressure of a fluid or gas to a desired value. Regulators are used for gases and liquids, and can be an integral device with a pressure setting, a restrictor and a sensor all in the one body, or consist of a separate pressure sensor, controller and flow valve.
8. CONTROL PANEL: This serves as a monitor that would serve as an interface to the operator and also the control unit, Operations and instructions would be carried out either automatically in response to the software or manually by the operator. It could be a computer system, on screen monitor or a phone.

SOFTWARE FEATURES OF THE SYSTEM

1) Smart scheduling: The irrigation software creates and automate irrigation schedules for specific land segments or zones using a timer and data from sensors.
2) Weather and soil monitoring: high tech sensors monitor the weather, soil condition, humidity and other factors to cut the water off if there is rain, wind or sufficient soil moisture levels. Data about the weather and soil is continuously updated to automatically adjust irrigation schedules based on the most recent local weather forecasts and soil conditions.
3) Notifications and alarm: the operator gets alerts for water leaks. Bad zone leaks, clogs and watering events, such alerts and warnings helps the operator to avoid potentially catastrophic outcomes

FLOWCHART FOR THE SOFTWARE DESIGN



ALGORITHM FOR THE SOFWARE DESIGN

STEP1 START
STEP2READ TEMPERATURE OF THE SOIL
STEP3 IF High and (above 65-70^{0}F0
STEP 4 READ THE SOIL MOISTURE OF THE SOIL
STEP 5 IF THE SOIL MOISTURE IS BELOW 20%
STEP 6START THE WATER PUMP
STEP 7 IF NOT BELOW 20% RETURN TO STEP 2

ALGORITHM FOR THE PASSWORD

START
READ PASSWORD
IF INCORRECT
PRINT ACESS DENIED
IF CORRECT
PRINT ACESS GRANTED

ALGORITHM FOR THE TIME INTERVAL

START
READ TANK LEVEL
IF ABOVE 50%
START IRRIGATION
IF NOT ABOVE 50%
START PUMP SYSTEM